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NOTIFICATION OF ELECTION

(PCT Rule 61.2)

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Applicant FORSTER, Ian, James et al	

1. The designated Office is hereby notified of its election made:

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2. The election [X] was

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The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer S. Mafla
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PATENT COOPERATION TREATY

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NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

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IMPORTANT NOTIFICATION

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1. The following indications appeared on record concerning:

[X] the applicant [ ] the inventor [ ] the agent [ ] the common representative

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3. Further observations, if necessary:

4. A copy of this notification has been sent to:

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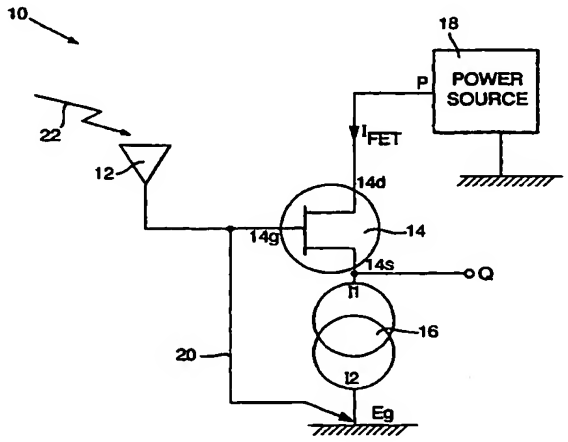
(54) Title: SUPERREGENERATIVE AM DEMODULATOR



(57) Abstract: The invention provides an AM receiver (10) incorporating an antenna (12), a transistor (14), a current source (16) and a power supply (18). The antenna (12) is connected to a gate electrode (14g) of the transistor (14) and through a link (20) to a signal earth. In operation, the antenna (12) receives radiation and generates a corresponding input signal which propagates to the gate electrode (14g). The transistor (14) is operable to process the input signal in two steps, namely to reflectively amplify the input signal to generate a correspondingly reflectively amplified input signal at the gate electrode (14g) in a first step, and amplitude demodulate the amplified input signal in a second step. The transistor (14) is operable in a non-linear region of its current/voltage characteristic whereat it simultaneously provides reflective amplification and signal demodulation, namely the two steps occur simultaneously. In contradistinction, conventional demodulators employing gain devices operating non-linearly to provide amplitude demodulation incorporate the devices configured to function as transmission amplifiers.

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SUPERREGENERATIVE AM DEMODULATOR

The present invention relates to an amplitude modulation (AM) receiver for amplifying and detecting amplitude modulated radiation and signals.

Conventional receivers operable to receive amplitude modulated radiation and generate corresponding demodulated signals, for example receivers such as domestic radios, often incorporate a number of sections; these sections conventionally comprise an antenna for receiving the radiation and generating a corresponding received signal, transmission radio frequency (r.f.) amplifiers for amplifying and filtering the received signal to provide an amplified signal and a detector for demodulating the amplified signal to provide a demodulated output signal. These sections consume significant power when operational, even when operating at reduced power in stand-by mode awaiting incoming radiation, for example awaiting radiation bearing "wake-up-codes" in mobile telephones. This significant power consumption is a problem which limits operating time from a given set of batteries supplying power to the sections. This problem also pertains to radio transponder tags incorporating miniature power cells to provide electrical power thereto, for example as incorporated into identity tags and electronic access keys for automobiles.

A further problem arises in conventional receivers where the received signal is often in the order of microvolts and where considerable amplification is required to provide amplified signals of sufficient magnitude to operate detection diodes in detectors of the receivers; such detectors often exhibit cutoff voltages which prevent them from detecting signals presented thereto below a minimum threshold amplitude. Because there is a practical limit to a degree of amplification that can be provided without risking spurious oscillations arising, this practical limit imposes a lower threshold amplitude for received radiation, and hence a

limited operating range, to which the receivers are responsive. This lower threshold amplitude is a problem in some applications, especially where more remote receiver operation is contemplated.

In conventional receivers, it is a well known principle that an r.f. transmission amplifier providing a non-linear transfer characteristic can be used as a demodulator for demodulating amplitude modulated signals. This principle was frequently employed in the context of thermionic electron tubes incorporated into radio receivers before a time when silicon semiconductor devices became widely available, the electron tubes functioning as transmission amplifiers.

The inventor has appreciated that it is feasible to combine a number of radio receiver sections together to obtain a simplified receiver circuit which counteracts one or more of the problems described above.

According to a first aspect of the present invention, there is provided an AM receiver for receiving an input signal and generating a corresponding demodulated signal, characterised in that the receiver incorporates a transistor biased to be simultaneously operable as a reflection amplifier for reflectively amplifying the input signal and as a detector for detecting the amplified input signal to generate the demodulated signal.

The invention provides the advantage that the receiver is capable of:

(a) consuming less power on account of exploiting reflective amplification, in contrast to transmission amplification employed in the prior art; and

(b) being more sensitive to the input signal because detection diodes imposing a lower response threshold are not incorporated therein.

Conveniently, detection of the amplified input signal occurs by the transistor providing signal mixing therein. Advantageously, the transistor is operable in a non-linear region of its current/voltage transfer characteristic. This provides the advantage that the amplified input signal is mixed with itself, namely "autoheterodyned", to demodulate it directly to baseband to provide the demodulated signal.

Advantageously, the transistor functions in its non-linear region at a relatively low supply current, thereby making the receiver more power efficient. Thus, for example, the transistor can be operable to conduct a current therethrough in a range of 5 μA to 100 μA when functioning in its non-linear region.

In order for the transistor to function simultaneously as a reflection amplifier and as a detector, the transistor is preferably configured so that amplified reflected signals are generated at an input of the transistor for subsequent detection in the transistor; the transistor presents a negative input resistance at its input to achieve this function. In contrast, conventional non-linear mixers employing transmission amplifiers do not generate amplified signals at their inputs and do not then inject them back for demodulation purposes. Conveniently, the transistor incorporates an electrode for receiving the input signal, the electrode being connected through a signal path to a signal earth such that the path is operable to convey reflected signals between the transistor and the signal earth, and to divert the input signal to the electrode.

According to a second aspect of the invention, receivers according to the first aspect of the invention can be incorporated into a GPS receiver, thereby providing it with relatively reduced operating current consumption and increased detection sensitivity. Conveniently,

the GPS receiver incorporates a plurality of receivers according to the invention, receiving means for receiving input radiation and generating a corresponding received signal, and processing means for filtering, amplifying and gating the received signal to provide input signals for the plurality of receivers to demodulate to provide demodulated signals from which a positional reference for the GPS receiver is derivable.

According to a third aspect of the invention, the invention provides a method of amplitude demodulating an input signal using an AM receiver according to the first aspect, the method comprising the simultaneously executable steps of:

(a) receiving the input signal and reflectively amplifying it in the transistor to generate an amplified input signal; and

(b) passing the amplified input signal through the transistor operating in a non-linear mode to demodulate it and thereby generate a corresponding demodulated signal.

Embodiments of the invention will now be described, by way of example only, with reference to the following diagrams in which:

Figure 1 is a schematic diagram of a first embodiment of an AM receiver according to the invention; and

Figure 2 is a schematic illustration of a GPS receiver incorporating the receiver shown in Figure 1.

Referring to Figure 1, there is illustrated an AM receiver indicated by 10. The receiver 10 incorporates a patch antenna 12, a gallium arsenide (GaAs) field effect transistor (FET) 14, a current source 16 and a power source 18. The antenna 12 is connected to a gate electrode

14g of the transistor 14 and also through a link 20 to a signal earth Eg. The power source 18 incorporates an output P connected to a drain electrode 14d of the transistor 14. The transistor 14 also incorporates a source electrode 14s which is connected to a first terminal I1 of the current source 16. A second terminal I2 of the source 16 is also connected to the signal earth Eg. The link 20 and the terminal I2 are both connected at a single point onto the signal earth Eg.

The source electrode 14s is also connected to an output Q whereat a demodulated signal is provided from the receiver 10.

Operation of the receiver 10 will now be described with reference to Figure 1. The transistor 14 is in a grounded gate configuration so that a positive bias provided by the power supply 18 at its output P causes a current I_{FET} in the order of microamperes to flow between the electrodes 14d, 14s and through the current source 16. Preferably, I_{FET} is in a range of 5 μA to 100 μA. The current I_{FET} is sufficiently small for the transistor 14 to operate as a reflection amplifier in a non-linear region of its transfer characteristics. It has been experimentally verified that the transistor 14 provides reflective amplification by measuring a signal gain provided by the receiver 10; it is not possible for the receiver 10 to provide such high amplification if the transistor 14 were functioning as a transmission amplifier. The current source 16 is operable to maintain the transistor 14 biased in the non-linear region.

The antenna 12 receives incoming radiation 22 and converts it to a received signal S_R. The signal S_R propagates from the antenna 12 to the gate electrode 14g and through the link 20. The link 20 provides an approximately quarter wavelength signal path between the signal earth Eg and the gate electrode 14g at the carrier frequency of the radiation 22; as a consequence, the link 20 does not divert the received signal S_R from the gate electrode 14g

because a low impedance presented by the link 20 where it connects to the earth Eg is transferred to an open circuit at the gate electrode 14g. The link 20 also functions as an impedance matching component; its length can be trimmed to afford an impedance match between the transistor 14 and the antenna 12.

The transistor 14 operates on the signal S_R in a two stage process, namely the transistor 14:

(a) amplifies the received signal S_R at its gate electrode 14g by reflection to generate an reflectively amplified signal S_A thereat; and then

(b) demodulates the signal S_A, by virtue of the transistor 14 providing a non-linear transfer characteristic, to output a demodulated signal at the source electrode 14s. The demodulated signal propagates to the output Q for subsequent processing.

In practice, the two stages (a) and (b) occur simultaneously.

In contrast to this two stage process, prior art demodulators do not provide in-situ reflective amplification and simultaneous detection and are therefore relatively less sensitive in comparison to the receiver 10. In contradistinction to the receiver 10, conventional demodulators employing gain devices operating non-linearly to provide amplitude demodulation incorporate the devices configured to function as transmission amplifiers. In its reflection mode of operation, the transistor 14 provides a square law signal transfer characteristic according to Equation 1:

$$i_{FET} = k_0 (v_{gs})^2 \qquad \text{Eq. 1}$$

where

i_{FET} = small signal change in I_{FET};

v_{gs} = small signal change in potential difference between the gate electrode 14g and source electrode 14s; and

k_0 = a gain constant.

Assuming to a first approximation that:

$$v_{gs} = k_1 S_R \qquad \text{Eq. 2}$$

where k_1 = constant,

and that:

$$S_R = k_2 S_m \sin \omega_R t \qquad \text{Eq. 3}$$

where

k_2 = a constant;

S_m = an amplitude modulating signal;

ω_R = angular carrier frequency of the radiation 22; and

t = time,

then from Equations 1 to 3:

$$i_{FET} = k_0 k_1^2 k_2^2 S_m^2 \sin^2 \omega_R t = \tfrac{1}{2} k_o k_1^2 k_2^2 S_m^2 (1-\cos 2 \omega_R t) \qquad \text{Eq. 4}$$

If high frequency components, namely at the angular frequency ω_R and higher, are filtered

out from the output Q, then the output will be according to Equation 5:

$$Q = k_3 S_m^2 \qquad \text{Eq. 5}$$

where k_3 = a constant, namely $k_3=k_0 k_1^2 k_2^2$.

In practice, filtration of the high frequency components will occur in circuits connected to the receiver 10, for example audio amplifiers exhibiting a bandwidth from 50 Hz to 20 kHz, which are not responsive to such components.

Equation 5 corresponds to a demodulated baseband signal at the output Q. Thus, the transistor 14 is capable of providing signal amplification at low operating currents and also providing direct demodulation to baseband.

If the signal S_m is digital binary data, non-linearity implicit in Equation 5 is inconsequential.

The receiver 10 provides the advantages that:

(i) it operates on relatively low currents, for example μA;

(ii) it provides both amplification and detection directly from high frequencies to baseband;

(iii) it is capable of operating with signals of relatively lower amplitude than conventional receivers; and

(iv) it is potentially cheap and requires few component parts.

The advantages make the receiver 10 attractive for use in short distance radio links such as

wireless local area computer networks, for remotely interrogatable identification tags, and for use as enhanced performance detectors in mobile telephones and in global positioning system (GPS) receivers.

The receiver 10 provides a synergistic advantage of reflective amplification and detection using a single transistor. Moreover, the receiver 10 is capable of operating at microwave frequencies, for example around 1.5 GHz; experimental results at these frequencies have demonstrated that it can amplify and detect amplitude modulated radiation giving rise to a received signal from the antenna 12 in the order of -80 dBm. The results demonstrate that the receiver 10 is a considerable improvement compared to conventional diode-type detectors which cannot detect such small received signals without considerable transmission amplification being employed to amplify the received signals prior to diode detection.

Applications of the receiver 10 include use as:

(a) low power receivers for multimode tag devices, for example personnel wearable tags. Conventional multimode tags are capable of transmitting messages in an active mode at a greater range than they are capable of receiving messages in a semi-passive mode. The active mode has the disadvantage that higher levels of power consumption are associated therewith compared to the semi-passive mode. Conventionally, tag power consumption can be reduced by sampling techniques where the tags enter their active mode for a relatively short period at intervals; use of these techniques results in complex operating protocols for the tags. The receiver 10 is capable of providing, when incorporated into a multimode tag, a highly sensitive "wake-up" receive capability which provides the tag with an enhanced operating range and reduces the need for complex operating protocols;

(b) security receivers for automobiles. Such security receivers incorporating the receiver 10 are capable of:

(1) exhibiting lower power consumption, for example consuming in the order of tens of μW;

(2) being of lower cost; and

(3) operating at ultra high frequencies (UHF) around 500 MHz to 600 MHz and above compared to conventional security receivers.

Security receivers incorporating the receiver 10 can be operative to communicate security codes, for example "radio keys" allowing authorised access to vehicles and control of immobilisation systems incorporated therein. The receiver 10 is sufficiently simple and compact to incorporate into a key fob, thereby enabling bi-directional communication links to be provided between vehicles and their associated key fobs. Such bi-directional links enable more complex security protocols to be used, thus enhancing security, and permits further added value functions to be added in the fobs, for example memorising an associated vehicle's parking position in a car park incorporating a constellation of low power radio transmitters from which the fobs can derive positional references; and

(c) ultra low power GPS receivers.

GPS receivers are well known for use in determining positional references on the earth's surface. A conventional GPS receiver functions by transmitting encoded radiation at a number of carrier frequencies in the order of 1.5 GHz to a constellation of equatorial geostationary satellites and measuring time durations for the radiation to reach the satellites, to be amplified therein and then transmitted therefrom and be received back at the GPS

receiver. Each satellite is responsive to radiation in a particular frequency range associated therewith. Distances corresponding to the time durations are calculated in the GPS receiver and geometrical computations then applied to determine a positional reference for the receiver from the distances because the positions of the satellites are known in advance. The radiation emitted by the GPS receiver is encoded by a pseudo-random bit sequence generated within the receiver; this encoding enables the GPS receiver to recognise its radiation transmitted back from the satellites.

Determination of time duration is achieved in the GPS receiver by correlating "early", "on time" and "late" versions of the pseudo-random bit sequence with radiation received back at the GPS receiver. This is necessary in order to ensure signal synchronisation and hence achieve a reliable and accurate time duration measurement.

Referring now to Figure 2, there is shown a GPS receiver indicated by 100. The receiver 100 incorporates a circularly polarised antenna 110, a magnetostatic surface wave device (MSWD) filter/isolator 120, a reflection amplifier 130, a three-way splitter unit 140, an assembly of reflection amplifiers 150, an assembly of narrowband surface acoustic wave filters 160, and an assembly of receivers 170. The assembly 170 incorporates three receivers 172, 174, 176 which are each identical to the receiver 10 in Figure 1. The receiver 100 also incorporates a measurement unit 178 for processing "late", "on time" and "early" outputs generated by the assembly 170 and generating signals at terminals J_1, J_2, J_3 for use in the assembly 150. Moreover, the receiver 100 additionally incorporates a computation unit 180 for determining a positional reference by triangulation from time measurements provided by the measurement unit 178 to provide the positional reference as data at a terminal M_0 of the unit 180. Design of the measurement unit 178 and the computation unit 178 will be familiar to one ordinary skilled in the art of GPS receiver design.

The reflection amplifier 130 and the assembly 150 incorporate reflection amplifiers according to our UK patent GB 2 284 323 B whose contents are hereby incorporated by reference with regard to transistors functioning as reflection amplifiers when operating in a linear region of their transfer characteristics. The reflection amplifiers each comprise a field effect transistor (FET), namely a silicon junction FET (JFET) or a gallium arsenide (GaAs) device, configured by means of a feedback arrangement such as to operate within a linear region of its current/voltage characteristic such that it reflects a signal received thereat with an increased magnitude.

The antenna 110 incorporates an output S_A which is connected to a first input terminal H_1 of the filter/isolator 120. The filter/isolator 120 incorporates a second terminal H_2 which is connected to an input/output terminal F of the amplifier 130, and also a third terminal H_3 which is connected to an input terminal K_0 of the splitter unit 140.

The unit 140 comprises three output terminals K_1, K_2, K_3 connected to input terminals B_1, B_2, B_3 of reflection amplifiers 152, 154, 156 respectively. The reflection amplifiers 152, 154, 156 are incorporated into the assembly 150. The amplifiers 152, 154, 156 also incorporate control terminals C_1, C_2, C_3 to which "late", "on time" and "early" control signals are connected from corresponding terminals J_1, J_2, J_3 of the measurement unit 178 respectively. These control signals are identical pseudo-random bit streams, namely sequences of data, which are time shifted with respect to one another, usually by a period corresponding to ½ or 1 bit duration in the sequences.

The terminals K_1, K_2, K_3 are also connected to inputs G_1, G_2, G_3 of surface acoustic wave (SAW) filters 162, 164, 166 respectively. The filters 162, 164, 166 incorporate outputs W_1,

W_2, W_3 which are connected to inputs Z_1, Z_2, Z_3 of the receivers 172, 174, 176 respectively. The receivers 172, 174, 176 include outputs D_1, D_2, D_3 at which "late", "on time" and "early" signals are output respectively. These outputs D_1, D_2, D_3 are connected to corresponding inputs E_1, E_2, E_3 of the measurement unit 178 respectively.

The filter/isolator 120 incorporates a thin layer, namely in a thickness range of 10 μm to 100 μm, of yttrium iron garnet (YIG) deposited onto an aluminum or quartz substrate, which provides a signal propagation path through the isolator 120.

The SAW filters 162, 164, 166 are operable to delay signals propagating therethrough and also bandpass filter them. The amplifier 130 is arranged to amplify signals received thereat and subsequently reflected therefrom by +23 dB. The receivers 172, 174, 176 are operable to provide +20 dB amplification gain as well as amplitude modulation detection as described above with reference to the receiver 10. The amplifiers 152, 154, 156 are switchable at their terminals C_1, C_2, C_3 respectively so that each provides +20 dB gain in a high gain state and -20 dB gain in a low gain state.

Operation of the GPS receiver 100 will now be described with reference to Figure 2.

The GPS receiver 100 emits from its transmitter units (not shown) connected to the measurement unit 178 encoded radiation to a first geostationary satellite (not shown) which amplifies and transmits the encoded radiation to provide input radiation 190 which is incident on the antenna 110.

The antenna 110 receives the input radiation 190, the radiation being C code GPS radiation at 1574.42 MHz frequency, and generates a signal S_1 corresponding thereto. The signal S_1

propagates to the first terminal H_1 of the filter/isolator 120 through which it passes to the second terminal H_2 whereat it is output to the terminal F of the amplifier 130; the filter/isolator 120 is operative to selectively limit components of the signal S_1 whose amplitude exceeds a threshold level, the level determined during manufacture of the filter/isolator 120. The amplifier 130 functions as a negative resistance and reflectively amplifies the signal S_1 to generate a corresponding amplified signal S_2 which propagates from the terminal F back to the terminal H_2 of the filter/isolator 120. The signal S_2 propagates from the terminal H_2 to the terminal H_3 at the filter/isolator 120 whereat it is output as a signal S_3. The signal S_3 propagates to the input K_0 of the splitter unit 140 which divides the signal S_3 to generate three signals S_{10}, S_{11}, S_{12} at the outputs K_1, K_2, K_3 respectively. In response to the control signals applied to the terminals C_1, C_2, C_3, the amplifiers 152, 154, 156 selectively reflectively amplify or attenuate the signals S_{10}, S_{11}, S_{12} respectively; thus, the signals S_{10}, S_{11}, S_{12} thereby become time gated such as to assume a prominent amplitude when correlation thereof with one or more of the control signals occurs.

The signals S_{10}, S_{11}, S_{12}, switched by the amplifiers 152, 154, 156 respectively to be amplified or attenuated, propagate to the inputs G_1, G_2, G_3 respectively. The filters 162, 164, 166 bandpass filter and delay the signals S_{10}, S_{11}, S_{12} propagating therethrough to provide corresponding signals S_{20}, S_{21}, S_{22} at the outputs W_1, W_2, W_3 respectively. The inputs Z_1, Z_2, Z_3 receive the signals S_{20}, S_{21}, S_{22} which pass to the receivers 172, 174, 176 whereat they are amplified and demodulated to provide "late", "on time" and "early" output signals at the outputs D_1, D_2, D_3 respectively. The signals D_1, D_2, D_3 propagate to the inputs E_1, E_2, E_3 respectively of the measurement unit 178.

The unit 178 monitors the inputs E1, E2, E3 to identify signals thereat corresponding to

correlation of the signals present at the terminals K_1, K_2, K_3 with those generated within the measurement unit 178 and output via the terminals J_1, J_2, J_3 to the terminals C_1, C_2, C_3 respectively. By doing so, the measurement unit 178 determines, by an iterative process, a time duration for radiation emitted from the receiver 100 to propagate to the first satellite and be received again by the receiver 100.

The receiver 100 repeats measurements as described above for second and third geostationary satellites to derive three time duration measurements. The measurement unit 178 outputs these measurements to the computation unit 180 which calculates therefrom corresponding distances from which a positional reference is calculated by a process of triangulation to provide positional data at an output M_0.

In broad overview, the control signals applied to the terminals C_1, C_2, C_3 are used to gate the signal S_1 from the antenna 110 to provide the output signals at the outputs D_1, D_2, D_3 which are processed by the units 178, 180 for determining the time durations and hence a positional reference for the receiver 100. Determination of the positional reference will be familiar to one ordinarily skilled in the art of GPS receiver design where the output signals at the outputs D_1, D_2, D_3 are used to steer a code generator incorporated into the measuring unit 178 for use in synchronisation and hence determining the time durations.

The GPS receiver 100 is capable of operating with lower power consumption compared to conventional GPS receivers. The receiver 100 achieves this lower consumption by exploiting reflective amplification in the amplifier 130, in the assembly of reflection amplifiers 150 and in the assembly of receivers 170. Exploitation of reflective amplification provides an additional advantage of allowing the receiver 100 to be fabricated into a GaAs microwave monolithic integrated circuit (MMIC) connected to associated MSWD and SAW

devices. Such a MMIC is potentially a relatively low-cost compact component for incorporation into GPS systems.

It will be appreciated by those skilled in the art that variations may be made to the receiver 10 and to the GPS receiver 100 described in the foregoing without departing from the scope of the invention. For example, the link 20 can be replaced by a filter network operative to bias the transistor 14 to provide reflective gain whilst imparting a narrower passband characteristic to the receiver 10, thereby making it more frequency selective. Moreover, the transistor 14 can be a silicon transistor when the circuit 10 is operable to receive radiation at relatively lower frequencies, for example at VHF frequencies in a range of 100 MHz to 150 MHz.

The receiver 10 is operable to inherently additionally provide an automatic gain control (AGC) characteristic for compressing the dynamic range of signals applied to the receiver 10. By appropriate choice of negative resistance exhibited by the transistor 14 at its gate electrode 14g, the current I_{FET} can be arranged to decrease in response to increased input signal strength so that the negative resistance exhibited at the gate electrode 14g changes to provide reduced gain.

By incorporating a frequency-sensitive cutoff filter, for example a bandpass filter, in a signal path between the antenna 12 and the gate electrode 14g, it is feasible to convert the AM receiver 10 into a frequency modulation (FM) receiver for demodulating frequency modulated radiation. The filter is operative, for example slightly off resonance, to provide signal attenuation for signals propagating therethrough in response to frequency change of the signals; such attenuation is manifest as amplitude modulation in signals provided from the filter which the transistor 14 is operative to demodulate. Moreover, because the receiver

10 can be adapted to be an FM receiver, it is also capable of functioning as a phase detector for demodulating phase modulated radiation and signals.

CLAIMS

1. An AM receiver for receiving an input signal (22) and generating a corresponding demodulated signal (Q), characterised in that the receiver (10) incorporates a transistor (14) biased to be simultaneously operable as a reflection amplifier for reflectively amplifying the input signal and as a detector for detecting the amplified input signal to generate the demodulated signal.

2. A receiver according to Claim 1 wherein the transistor (14) is operative in a non-linear region of its current/voltage transfer characteristic.

3. A receiver according to Claim 2 wherein the transistor is operable to conduct a current therethrough in a range of 5 μA to 100 μA to function in its non-linear region.

4. A receiver according to Claim 1, 2 or 3 wherein the transistor (14) incorporates an electrode (14g) for receiving the input signal, the electrode connected through a signal path (20) to a signal earth such that the path (20) is operable to convey reflected signals between the transistor and the signal earth, and to divert the input signal to the electrode (14g).

5. A receiver according to Claim 1, 2, 3 or 4 wherein the receiver (10) incorporates an antenna assembly (12) for receiving input radiation (22) and generating therefrom the input signal for the transistor.

6. A receiver according to Claim 1, 2, 3 or 4 arranged to provide a gain therethrough

which is responsive to input signal magnitude, thereby providing the receiver with an AGC characteristic.

7. An FM receiver incorporating an AM receiver according to any one of Claims 1 to 6, the FM receiver further comprising converting means for converting an input frequency modulated signal applied thereto into a corresponding amplitude modulated signal which the AM receiver is operable to demodulate to provide a demodulated output signal.

8. A receiver according to Claim 7 wherein the converting means comprises a band pass filter operable off resonance to convert the frequency modulated signal into the corresponding amplitude modulated signal.

9. A GPS receiver (100) incorporating one or more receivers (170) according to Claim 1, 2, 3, 4, 6 or 7, receiving means (120, 130) for receiving input radiation and generating a corresponding received signal (K_0), and processing means (140, 150, 160, 170, 178, 180) for filtering, amplifying and gating the received signal (K_0) to provide input signals for the one or more receivers (170) to demodulate to provide demodulated signals from which a positional reference for the GPS receiver (100) is derivable.

10. A receiver according to Claim 9 wherein the receiving means is a circularly polarised antenna.

11. A receiver according to Claim 9 or 10 wherein the processing means (140, 150, 160, 170, 178, 180) incorporates reflection amplifiers (172, 174, 176) for amplifying and

gating the received signal for generating the processed signals.

12. A receiver according to Claim 9, 10 or 11 wherein the processing means incorporates magnetostatic filtering and frequency selective limiting means (160) for processing the received signal.

13. An identification tag incorporating a receiver according to any one of Claims 1 to 8 operable to be responsive to radio radiation received thereat.

14. A wireless local area network for interconnecting computers, the network incorporating a receiver according to any one of Claims 1 to 8 for performing demodulation of signals within the network.

15. A mobile telephone incorporating a receiver according to any one or Claims 1 to 8 operable to provide demodulation of signals propagating therein.

16. An electronic security key incorporating a receiver according to any one of Claim 1 to 8 for performing demodulation of signals propagating therein.

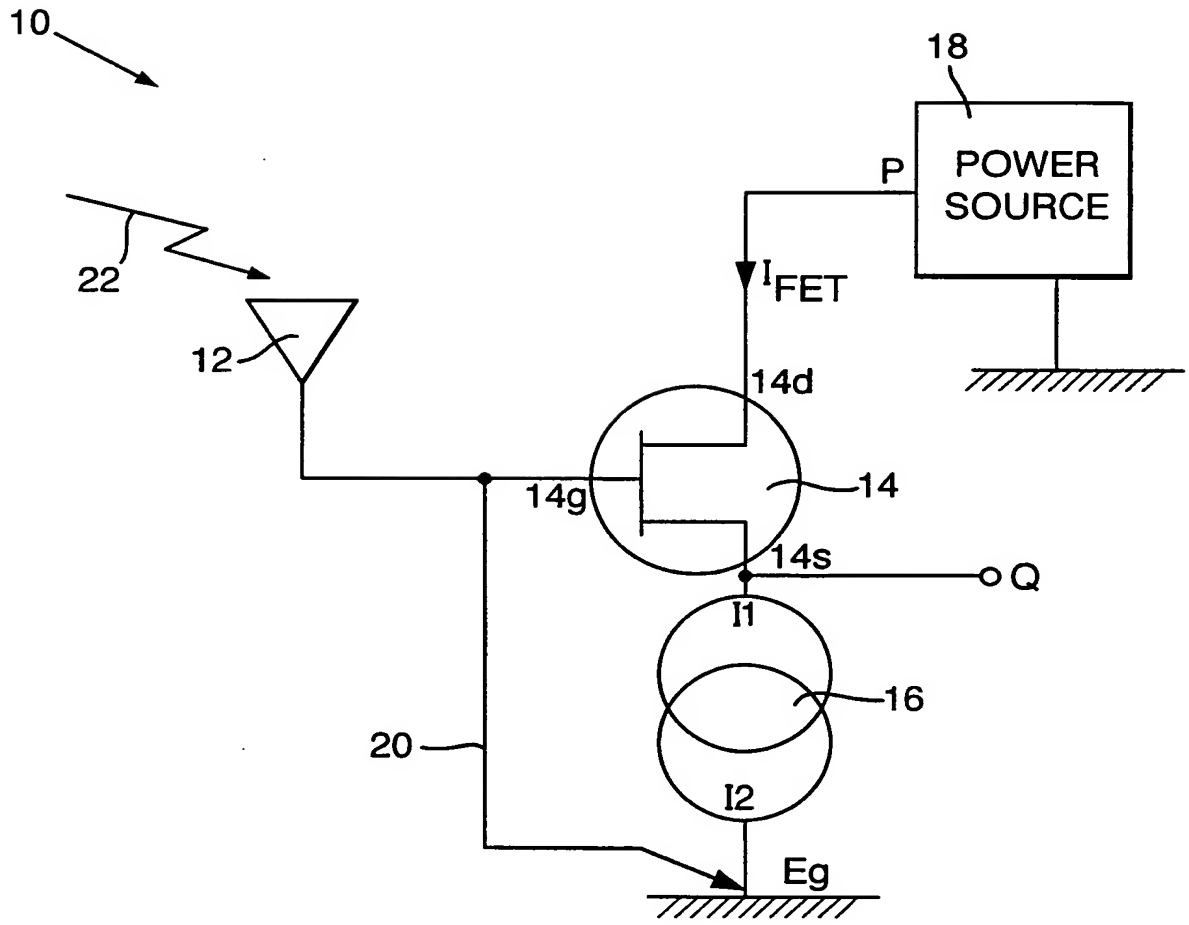
17. A key according to Claim 16 wherein the receiver is housed within a key fob.

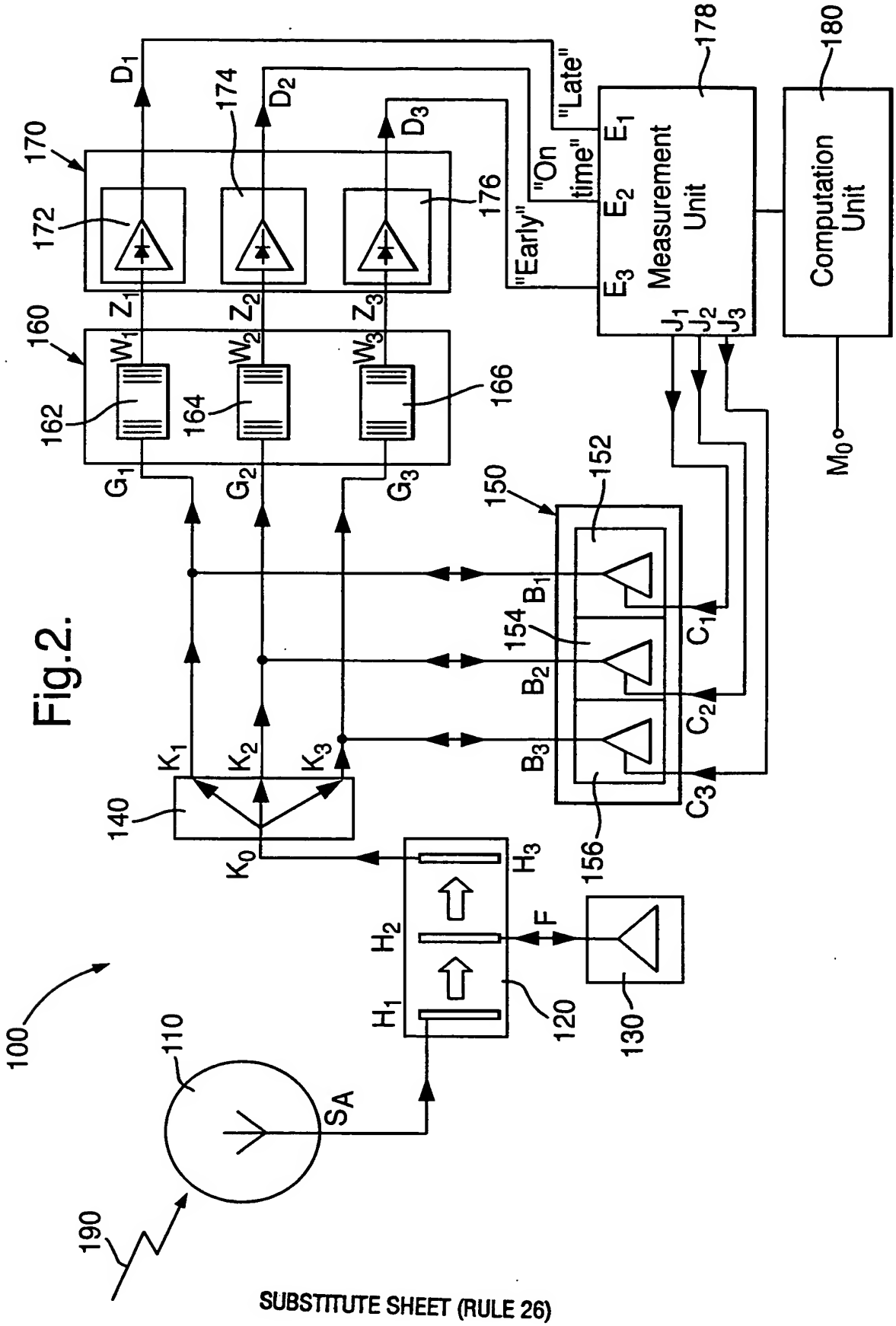
18. A method of amplitude demodulating an input signal using an AM receiver (10) according to Claim 1, the method comprising the simultaneously executable steps of:

(a) receiving the input signal and reflectively amplifying it in the transistor (14) to generate an amplified input signal; and

(b) passing the amplified input signal through the transistor (14) operating in a non-linear mode to demodulate it and thereby generate a corresponding demodulated signal (Q).

Fig.1.

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180
D_1
D_2
D_3
"Late"
"On time"
"Early"
E_1
E_2
E_3
Measurement Unit
Computation Unit
J_1
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B_3
C_1
C_2
C_3
K_0
K_1
K_2
K_3
H_1
H_2
H_3
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Fig.2.

EPA/EPO/OEB
D-80298 München
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TX 523 656 epmu d
FAX +49 89 2399-4465

Correspondence with the EPO on PCT Chapter II demands

In order to ensure that your PCT Chapter II demand is dealt with as promptly as possible you are requested to use the enclosed self-adhesive labels with any correspondence relating to the demand sent to the Munich Office.

One of these labels should be affixed to a prominent place in the upper part of the letter or form etc. which you are filing.

The Patent Office

INVESTOR IN PEOPLE

Application No: GB 9913989.1
Claims searched: 1 to 20

Examiner: John Donaldson
Date of search: 3 September 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): H3R(RADB, RADC, RADX)

Int Cl (Ed.6): H03D 1/00, 1/14, 1/18, 1/22

Other: Online:WPI, EPODOC

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	GB 2284323 A (GEC-MARCONI), see abstract	-

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION** see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
P/61728/MRCE		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/GB 00/ 02093	01/06/2000	17/06/1999
Applicant		
MARCONI CASWELL LIMITED		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   [ ] the text is approved as submitted by the applicant.

   [X] the text has been established by this Authority to read as follows:

   SUPERREGEBERATIVE AM DEMODULtor

5. With regard to the **abstract,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 1

   [X] as suggested by the applicant.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 00/02093

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H03D7/12 H03D11/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H03D H03B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
WPI Data, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 563 772 A (H. BENEKING) 7 January 1986 (1986-01-07) column 1, line 26 -column 2, line 47; figure 1	1-6,9-18
X	US 4 631 500 A (C. RAUSCHER) 23 December 1986 (1986-12-23) column 3, line 16 -column 4, line 29; figure 2	1-6,9-18
X	US 4 112 373 A (H. MIYAMOTO) 5 September 1978 (1978-09-05) column 2, line 34 -column 3, line 62; figures 1,2	1-6,9-18

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 September 2000	04/10/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Butler, N

3

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 863 136 A (R. HANSON) 28 January 1975 (1975-01-28) column 1, line 33 -column 3, line 23; figure 1	1-6,9-18
X	US 4 403 347 A (Y. ISO) 6 September 1983 (1983-09-06) column 2, line 8 -column 3, line 53; figures 1,2	1-6,9-18
A	J. SARKISSIAN: "A 60 GHZ HEMT-MMIC ANALOG FREQUENCY DIVIDER BY TWO" IEEE GALLIUM ARSENIDE INTEGRATED CIRCUITS SYMPOSIUM, 16 October 1994 (1994-10-16), pages 104-107, XP000482723 PHILADELPHIA,PENNSYLVANNIA page 105, column 1, line 27 -column 2, line 15; figure 8	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 00/02093

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4563772 A	07-01-1986	DE 3216776 A	17-11-1983
		FR 2526606 A	10-11-1983
		GB 2120035 A,B	23-11-1983
		JP 58204609 A	29-11-1983
US 4631500 A	23-12-1986	NONE	
US 4112373 A	05-09-1978	JP 1193116 C	29-02-1984
		JP 52087912 A	22-07-1977
		JP 58024977 B	24-05-1983
		JP 52087913 A	22-07-1977
		JP 1194818 C	12-03-1984
		JP 52087914 A	22-07-1977
		JP 58026702 B	04-06-1983
		JP 1325730 C	16-07-1986
		JP 53068504 A	19-06-1978
		JP 60044842 B	05-10-1985
		AU 503157 B	23-08-1979
		AU 2140177 A	27-07-1978
US 3863136 A	28-01-1975	NONE	
US 4403347 A	06-09-1983	JP 1515615 C	24-08-1989
		JP 56111326 A	03-09-1981
		JP 63061811 B	30-11-1988
		DE 3104242 A	07-01-1982

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

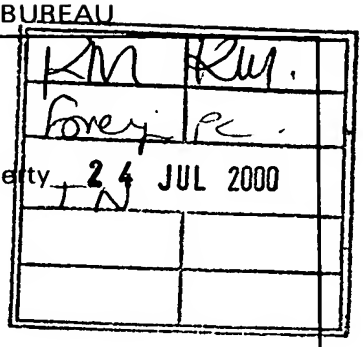
PCT

NOTIFICATION OF RECEIPT OF RECORD COPY

(PCT Rule 24.2(a))

To:

COCKAYNE, Gillian
Marconi Intellectual Property
Waterhouse Lane
Chelmsford
Essex CM1 2QX
ROYAUME-UNI



Date of mailing (day/month/year)	IMPORTANT NOTIFICATION
12 July 2000 (12.07.00)	
Applicant's or agent's file reference	**International application No.**
P/61728/MRCE	PCT/GB00/02093

The applicant is hereby notified that the International Bureau has received the record copy of the international application as detailed below.

Name(s) of the applicant(s) and State(s) for which they are applicants:

MARCONI CASWELL LIMITED (for all designated States except US)
FORSTER, Ian, James et al (for US)

International filing date	:	01 June 2000 (01.06.00)
Priority date(s) claimed	:	17 June 1999 (17.06.99)
Date of receipt of the record copy by the International Bureau	:	28 June 2000 (28.06.00)
List of designated Offices	:	

AP :GH,GM,KE,LS,MW,MZ,SD,SL,SZ,TZ,UG,ZW
EA :AM,AZ,BY,KG,KZ,MD,RU,TJ,TM
EP :AT,BE,CH,CY,DE,DK,ES,FI,FR,GB,GR,IE,IT,LU,MC,NL,PT,SE
OA :BF,BJ,CF,CG,CI,CM,GA,GN,GW,ML,MR,NE,SN,TD,TG
National :AE,AG,AL,AM,AT,AU,AZ,BA,BB,BG,BR,BY,CA,CH,CN,CR,CU,CZ,DE,DK,DM,DZ,EE,ES, FI,GB,GD,GE,GH,GM,HR,HU,ID,IL,IN,IS,JP,KE,KG,KP,KR,KZ,LC,LK,LR,LS,LT,LU,LV,MA,MD, MG,MK,MN,MW,MX,MZ,NO,NZ,PL,PT,RO,RU,SD,SE,SG,SI,SK,SL,TJ,TM,TR,TT,TZ,UA,UG,US,UZ, VN,YU,ZA,ZW

ATTENTION

The applicant should carefully check the data appearing in this Notification. In case of any discrepancy between these data and the indications in the international application, the applicant should immediately inform the International Bureau.

In addition, the applicant's attention is drawn to the information contained in the Annex, relating to:

- [X] time limits for entry into the national phase
- [ ] confirmation of precautionary designations
- [X] requirements regarding priority documents

A copy of this Notification is being sent to the receiving Office and to the International Searching Authority.

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer:

Eugénia Santos

Telephone No. (41-22) 338.83.38

INFORMATION ON TIME LIMITS FOR ENTERING THE NATIONAL PHASE

The applicant is reminded that the "national phase" must be entered before each of the designated Offices indicated in the Notification of Receipt of Record Copy (Form PCT/IB/301) by paying national fees and furnishing translations, as prescribed by the applicable national laws.

The time limit for performing these procedural acts is **20 MONTHS** from the priority date or, for those designated States which the applicant elects in a demand for international preliminary examination or in a later election, **30 MONTHS** from the priority date, provided that the election is made before the expiration of 19 months from the priority date. Some designated (or elected) Offices have fixed time limits which expire even later than 20 or 30 months from the priority date. In other Offices an extension of time or grace period, in some cases upon payment of an additional fee, is available.

In addition to these procedural acts, the applicant may also have to comply with other special requirements applicable in certain Offices. **It is the applicant's responsibility** to ensure that the necessary steps to enter the national phase are taken in a timely fashion. Most designated Offices do not issue reminders to applicants in connection with the entry into the national phase.

For detailed information about the procedural acts to be performed to enter the national phase before each designated Office, the applicable time limits and possible extensions of time or grace periods, and any other requirements, see the relevant Chapters of Volume II of the PCT Applicant's Guide. Information about the requirements for filing a demand for international preliminary examination is set out in Chapter IX of Volume I of the PCT Applicant's Guide.

GR and ES became bound by PCT Chapter II on 7 September 1996 and 6 September 1997, respectively, and may, therefore, be elected in a demand or a later election filed on or after 7 September 1996 and 6 September 1997, respectively, regardless of the filing date of the international application. (See second paragraph above.)

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

CONFIRMATION OF PRECAUTIONARY DESIGNATIONS

This notification lists only specific designations made under Rule 4.9(a) in the request. It is important to check that these designations are correct. Errors in designations can be corrected where precautionary designations have been made under Rule 4.9(b). The applicant is hereby reminded that any precautionary designations may be confirmed according to Rule 4.9(c) before the expiration of 15 months from the priority date. If it is not confirmed, it will automatically be regarded as withdrawn by the applicant. There will be no reminder and no invitation. Confirmation of a designation consists of the filing of a notice specifying the designated State concerned (with an indication of the kind of protection or treatment desired) and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.

REQUIREMENTS REGARDING PRIORITY DOCUMENTS

For applicants who have not yet complied with the requirements regarding priority documents, the following is recalled.

Where the priority of an earlier national, regional or international application is claimed, the applicant must submit a copy of the said earlier application, certified by the authority with which it was filed ("the priority document") to the receiving Office (which will transmit it to the International Bureau) or directly to the International Bureau, before the expiration of 16 months from the priority date, provided that any such priority document may still be submitted to the International Bureau before that date of international publication of the international application, in which case that document will be considered to have been received by the International Bureau on the last day of the 16-month time limit (Rule 17.1(a)).

Where the priority document is issued by the receiving Office, the applicant may, instead of submitting the priority document, request the receiving Office to prepare and transmit the priority document to the International Bureau. Such request must be made before the expiration of the 16-month time limit and may be subjected by the receiving Office to the payment of a fee (Rule 17.1(b)).

If the priority document concerned is not submitted to the International Bureau or if the request to the receiving Office to prepare and transmit the priority document has not been made (and the corresponding fee, if any, paid) within the applicable time limit indicated under the preceding paragraphs, any designated State may disregard the priority claim, provided that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity to furnish the priority document within a time limit which is reasonable under the circumstances.

Where several priorities are claimed, the priority date to be considered for the purposes of computing the 16-month time limit is the filing date of the earliest application whose priority is claimed.

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING SUBMISSION OR TRANSMITTAL OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

COCKAYNE, Gillian
Marconi Intellectual Property
Waterhouse Lane
Chelmsford
Essex CM1 2QX
ROYAUME-UNI

24 AUG 2000

Date of mailing (day/month/year) 17 August 2000 (17.08.00)	
Applicant's or agent's file reference P/61728/MRCE	**IMPORTANT NOTIFICATION**
International application No. PCT/GB00/02093	International filing date (day/month/year) 01 June 2000 (01.06.00)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 17 June 1999 (17.06.99)
Applicant MARCONI CASWELL LIMITED et al	

1. The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).

2. This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.

3. An **asterisk(*)** appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

4. The **letters "NR"** appearing in the right-hand column denote a priority document which was not received by the International Bureau or which the applicant did not request the receiving Office to prepare and transmit to the International Bureau, as provided by Rule 17.1(a) or (b), respectively. In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

Priority date	Priority application No.	Country or regional Office or PCT receiving Office	Date of receipt of priority document
17 June 1999 (17.06.99)	9913989.1	GB	27 July 2000 (27.07.00)

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer

Eugénia Santos

Telephone No. (41-22) 338.83.38

WO 00/79678
PCT/GB00/02093

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

To:
COCKAYNE, Gillian
Marconi Intellectual Property
Waterhouse Lane
Chelmsford
Essex CM1 2QX
ROYAUME-UNI

Date of mailing (day/month/year) 28 December 2000 (28.12.00)	
Applicant's or agent's file reference P/61728/MRCE	**IMPORTANT NOTICE**

International application No.	**International filing date** (day/month/year)	**Priority date** (day/month/year)
PCT/GB00/02093	01 June 2000 (01.06.00)	17 June 1999 (17.06.99)

Applicant
MARCONI CASWELL LIMITED et al

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
   AG,AU,DZ,KP,KR,MZ,US

   In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:
   AE,AL,AM,AP,AT,AZ,BA,BB,BG,BR,BY,CA,CH,CN,CR,CU,CZ,DE,DK,DM,EA,EE,EP,ES,FI,GB,GD,
   GE,GH,GM,HR,HU,ID,IL,IN,IS,JP,KE,KG,KZ,LC,LK,LR,LS,LT,LU,LV,MA,MD,MG,MK,MN,MW,MX,
   NO,NZ,OA,PL,PT,RO,RU,SD,SE,SG,SI,SK,SL,TJ,TM,TR,TT,TZ,UA,UG,UZ,VN,YU,ZA,ZW
   The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on
   28 December 2000 (28.12.00) under No. WO 00/79678

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, **a demand for international preliminary examination** must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the **national phase**, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer
J. Zahra

Telephone No. (41-22) 338.83.38

PATENT COOPERATION TREATY

From the:
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

COCKAYNE, Gillian
MARCONI Int.Property
Waterhouse Lane
Chelmsford
Essex CM1 2QX
GRANDE BRETAGNE

KM KM NCM

PCT

23 MAR 2001

WRITTEN OPINION

(PCT Rule 66)

Date of mailing *(day/month/year)*	21.03.2001
Applicant's or agent's file reference P/61728/MRCE	**REPLY DUE** **within 3 month(s)** from the above date of mailing

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/02093	01/06/2000	17/06/1999

International Patent Classification (IPC) or both national classification and IPC

H03D7/12

Applicant

MARCONI CASWELL LIMITED

1. This written opinion is the **first** drawn up by this International Preliminary Examining Authority.

2. This opinion contains indications relating to the following items:

I	☒	Basis of the opinion
II	☐	Priority
III	☐	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	☐	Lack of unity of invention
V	☒	Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	☐	Certain document cited
VII	☐	Certain defects in the international application
VIII	☐	Certain observations on the international application

3. The applicant is hereby **invited to reply** to this opinion.

When? See the time limit indicated above. The applicant may, before the expiration of that time limit, request this Authority to grant an extension, see Rule 66.2(d).

How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.

Also: For an additional opportunity to submit amendments, see Rule 66.4. For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4 bis. For an informal communication with the examiner, see Rule 66.6.

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.

4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 17/10/2001.

Name and mailing address of the international preliminary examining authority:

European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0 Tx: 523656 epmu d
Fax: +49 89 2399 - 4465

Authorized officer / Examiner

Dietsche, S

Formalities officer (incl. extension of time limits)
ANDREATTA, R
Telephone No. +49 89 2399 7581

I. Basis of the opinion

1. This opinion has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed".*):

Description, pages:

1-17 as published

Claims, No.:

1-18 as published

Drawings, sheets:

1/2-2/2 as published

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrialapplicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	
Inventive step (IS)	Claims	1-18
Industrial applicability (IA)	Claims	

2. Citations and explanations
   see separate sheet

1. **The following document** which was already cited in the description (page 12, line 2) of the present application is considered to represent the state of the art the closest to that of the present application and **will be**, therefore, **referred to in this written opinion.** A Copy of this document is appended hereto.

D1 = GB-2 284 323

2. **With reference to item V**, the examiner is of the provisional opinion that the application does not meet the requirements of Art. 33 (3) PCT, because the subject-matter of the claims 1-18 does not involve an inventive step.

2.1 In consideration of the wording used in present claim 1, document D1 discloses in the description (page 1, line 15 to page 6, line 9) and in the drawings (fig. 1 and 4) an AM receiver for receiving an input signal (from 2) and generating a corresponding demodulated signal (page 1, line 22 to page 2, line 2) wherein the receiver incorporates a transistor (1) biased to be operable as a refection amplifier (fig. 2: B) for reflectively amplifying the input signal and as a detector (fig. 2: A) for detecting the input signal to generate the demodulated signal.

Thus, the subject-matter of the present claim 1 differs from the disclosure of D1 merely in that

- the transistor is biased to be "simultaneously" operable as a reflection amplifier, thus the transistor amplifies and
- detects the "amplified" input signal.

As is widely known in the art (e.g. from D1, fig. 2), the operation of a transistor, and thus the technical effect/s provided by the transistor, depend on its bias conditions. In this context, document D1 defines three different bias conditions (fig. 2) labelled "A", "B" and "C", respectively. "With the transistor operating within the non-linear ... region A it can ... act as a detector ... . Increasing the drain current further the transistor operates in the ... gain region B ... . The transistor then acts as a negative resistance or amplifier reflecting any incoming signals with an increased amplitude (page 4, lines 7-12)". Although document D1 defines different bias conditions each causing a different technical effect, it is clear to a person skilled in the art that in practice such a clear distinction is generally not possible,

since the technical effects provided by the transistor depend not only on the bias conditions, including the individual amplitude of the input signal, but also on the individual properties of the transistor as such and on the electrical properties of the circuit surrounding the transistor. Thus, the skilled person merely faced with the problem to realise and to use the circuit arrangement disclosed in D1 as a detector would observe that, in consideration of the individual circumstances as elaborated above, the transistor simultaneously operates as a reflection amplifier and as a detector detecting the amplified input signal.

Despite this case where the skilled person would observe this effect simply by realising the circuit arrangement disclosed in D1, the subject-matter of claim 1 is furthermore obvious when considering a skilled person faced with the problem to optimise the dynamic range of the circuit arrangement of D1, to be used as a detector, with respect to the dynamic range of the amplitude modulated input signal. As is known from D1 (page 4, lines 7-9; fig. 2), the dynamic range of the circuit of D1 used as a detector is basically limited by the fact that low amplitude input signals are harder to detect than input signals having a higher amplitude. To optimise the dynamic range of the detector, it is an obvious design possibility for a person skilled in the art to alter the bias condition accordingly (e.g. by moving the region "A" closer to the region "B"). Since there is always a transition between the different regions, the skilled person faced with the problem to optimise the dynamic range of the circuit arrangement of D1 used as a detector would likewise observe that, in consideration of the individual circumstances as elaborated above, the transistor simultaneously operates as a reflection amplifier and as a detector detecting the amplified input signal.

Thus, the subject-matter of the present claim 1 does not involve any inventive step in the sense of Art. 33 (3) PCT.

2.2 While the subject-matter of the dependent claims 2-6 is either known from or rendered obvious by the available prior art (e.g. D1), the subject-matter of the dependent claims 7-17 merely refers to different generally known devices having in common the use of the circuit arrangement claimed in claim 1. In conclusion, none of the dependent claims 2-17 appears to involve an inventive step in the sense of Art. 33 (3) PCT.

2.3 The subject-matter of the independent method claim 18 does not involve any inventive step in the sense of Art. 33 (3) PCT for substantially the same reasoning as elaborated above with respect to the subject-matter of the corresponding independent apparatus claim 1.

3. In view of the available prior art, the examiner is of the provisional opinion that the present application does not contain any subject-matter on which an independent claim meeting the requirements of Art. 33 (2) (3) and (4) PCT could be based.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
P/61728/MRCE		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/02093	01/06/2000	17/06/1999
International Patent Classification (IPC) or national classification and IPC H03D7/12		
Applicant MARCONI CASWELL LIMITED		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
11/01/2001	10.09.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Dietsche, S Telephone No. +49 89 2399 7465

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/02093

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1-17 as published

Claims, No.:

1-18 as published

Drawings, sheets:

1/2-2/2 as published

2. With regard to the **language,** all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-18
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-18
Industrial applicability (IA)	Yes:	Claims	1-18
	No:	Claims	

2. Citations and explanations
see separate sheet

1. **The following document** which was already cited in the description (page 12, line 2) of the present application is considered to represent the state of the art the closest to that of the present application and **will be**, therefore, **referred to in this international preliminary examination report**.

D1 = GB-2 284 323

2. **With reference to item V**, the examiner is of the opinion that the application does not meet the requirements of Art. 33 (3) PCT, because the subject-matter of the claims 1-18 does not involve an inventive step.

2.1 In consideration of the wording used in present claim 1, document D1 discloses in the description (page 1, line 15 to page 6, line 9) and in the drawings (fig. 1 and 4) an AM receiver for receiving an input signal (from 2) and generating a corresponding demodulated signal (page 1, line 22 to page 2, line 2) wherein the receiver incorporates a transistor (1) biased to be operable as a refection amplifier (fig. 2: B) for reflectively amplifying the input signal and as a detector (fig. 2: A) for detecting the input signal to generate the demodulated signal.

Thus, the subject-matter of the present claim 1 differs from the disclosure of D1 merely in that

- the transistor is biased to be "simultaneously" operable as a reflection amplifier, thus the transistor amplifies and
- detects the "amplified" input signal.

As is widely known in the art (e.g. from D1, fig. 2), the operation of a transistor, and thus the technical effects provided by the transistor, depend on its bias conditions. In this context, document D1 defines three different bias conditions (fig. 2) labelled "A", "B" and "C", respectively. "With the transistor operating within the non-linear ... region A it can ... act as a detector ... . Increasing the drain current further the transistor operates in the ... gain region B ... . The transistor then acts as a negative resistance or amplifier reflecting any incoming signals with an increased amplitude (page 4, lines 7-12)". Although document D1 defines different bias conditions each causing a different technical effect, it is clear to a person skilled in the art that in practice such a clear distinction is generally not possible,

since the technical effects provided by the transistor depend not only on the bias conditions, including the individual amplitude of the input signal, but also on the individual properties of the transistor as such and on the electrical properties of the circuit surrounding the transistor. Thus, the skilled person merely faced with the problem to realise and to use the circuit arrangement disclosed in D1 as a detector would observe that, depending on the individual circumstances as elaborated above, the transistor simultaneously operates as a reflection amplifier and as a detector detecting the amplified input signal.

Despite this case where the skilled person would observe this effect simply by realising the circuit arrangement disclosed in D1, the subject-matter of claim 1 is furthermore obvious when considering a skilled person faced with the problem to optimise the dynamic range of the circuit arrangement of D1, to be used as a detector, with respect to the dynamic range of the amplitude modulated input signal. As is known from D1 (page 4, lines 7-9; fig. 2), the dynamic range of the circuit of D1 used as a detector is basically limited by the fact that low amplitude input signals are harder to detect than input signals having a higher amplitude. To optimise the dynamic range of the detector, it is an obvious design possibility for a person skilled in the art to alter the bias condition accordingly (e.g. by moving the region "A" closer to the region "B"). Since there is always a transition between the different regions, the skilled person faced with the problem to optimise the dynamic range of the circuit arrangement of D1 used as a detector would likewise observe that, in consideration of the individual circumstances as elaborated above, the transistor simultaneously operates as a reflection amplifier and as a detector detecting the amplified input signal.

Thus, the subject-matter of the present claim 1 does not involve any inventive step in the sense of Art. 33 (3) PCT.

2.2 While the subject-matter of the dependent claims 2-6 is either known from or rendered obvious by the available prior art (e.g. D1), the subject-matter of the dependent claims 7-17 merely refers to different generally known devices having in common the use of the circuit arrangement claimed in claim 1. In conclusion, none of the dependent claims 2-17 appears to involve an inventive step in the sense of Art. 33 (3) PCT.

2.3 The subject-matter of the independent method claim 18 does not involve any inventive step in the sense of Art. 33 (3) PCT for substantially the same reasoning as elaborated above with respect to the subject-matter of the corresponding independent apparatus claim 1.

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

COCKAYNE, Gillian
MARCONI Int.Property
Waterhouse Lane
Chelmsford
Essex CM1 2QX
GRANDE BRETAGNE

KM KM
NCM
13 SEP 2001
FOREIGNS PC

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing *(day/month/year)*	10.09.2001
Applicant's or agent's file reference P/61728/MRCE	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/02093	01/06/2000	17/06/1999

Applicant
MARCONI CASWELL LIMITED

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	HUE, S Tel.+49 89 2399-7573

Form PCT/IPEA/416 (July 1992)

INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/GB 00/02093

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H03D7/12 H03D11/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H03D H03B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
WPI Data, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 563 772 A (H. BENEKING) 7 January 1986 (1986-01-07) column 1, line 26 -column 2, line 47; figure 1	1-6,9-18
X	US 4 631 500 A (C. RAUSCHER) 23 December 1986 (1986-12-23) column 3, line 16 -column 4, line 29; figure 2	1-6,9-18
X	US 4 112 373 A (H. MIYAMOTO) 5 September 1978 (1978-09-05) column 2, line 34 -column 3, line 62; figures 1,2	1-6,9-18

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 September 2000	04/10/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Butler, N

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Inter. ...nal Application No
PCT/GB 00/02093

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 863 136 A (R. HANSON) 28 January 1975 (1975-01-28) column 1, line 33 -column 3, line 23; figure 1	1-6,9-18
X	US 4 403 347 A (Y. ISO) 6 September 1983 (1983-09-06) column 2, line 8 -column 3, line 53; figures 1,2	1-6,9-18
A	J. SARKISSIAN: "A 60 GHZ HEMT-MMIC ANALOG FREQUENCY DIVIDER BY TWO" IEEE GALLIUM ARSENIDE INTEGRATED CIRCUITS SYMPOSIUM, 16 October 1994 (1994-10-16), pages 104-107, XP000482723 PHILADELPHIA,PENNSYLVANNIA page 105, column 1, line 27 -column 2, line 15; figure 8	1

3

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter[illegible]tional Application No
PCT/GB 00/02093

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4563772 A	07-01-1986	DE 3216776 A	17-11-1983
		FR 2526606 A	10-11-1983
		GB 2120035 A,B	23-11-1983
		JP 58204609 A	29-11-1983
US 4631500 A	23-12-1986	NONE	
US 4112373 A	05-09-1978	JP 1193116 C	29-02-1984
		JP 52087912 A	22-07-1977
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		JP 58026702 B	04-06-1983
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		JP 53068504 A	19-06-1978
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		AU 503157 B	23-08-1979
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US 3863136 A	28-01-1975	NONE	
US 4403347 A	06-09-1983	JP 1515615 C	24-08-1989
		JP 56111326 A	03-09-1981
		JP 63061811 B	30-11-1988
		DE 3104242 A	07-01-1982